Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 57B WORKMAN SITE: TARGET AREA OPERABLE UNIT 1334

September 1997

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

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WORKMAN SITE: TARGET AREA
OPERABLE UNIT 1334
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Prepared by
Sandia National Laboratories/New Mexico
Environmental Restoration Project
Albuquerque, New Mexico

Prepared for
the U. S. Department of Energy

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituents of concern
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FOP	Field Operating Procedure
HE	high explosive(s)
HPLC	High-Pressure Liquid Chromatography
KAFB	Kirtland Air Force Base
MDA	minimum detectable activity
MDL	method detection limit
MEKC	Micellar Electrokinetic Capillary Chromatography
mg/kg	milligram(s) per kilogram
mrem/yr	millirem per year
NFA	No Further Action
NMED	New Mexico Environment Department
OB	Oversight Bureau
OU	Operable Unit
pCi/g	picocurie(s) per gram
PID	photoionization detector
QA	quality assurance
QC	quality control
Ra	radium
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
SWMU	Solid Waste Management Unit
Th	thorium
TPH	total petroleum hydrocarbons
U	uranium
UXO	unexploded ordnance
VCM	Voluntary Corrective Measure
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Description of ER Site 57B

Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Site 57B is located at the east end of Isleta Road on the boundary of Kirtland Air Force Base (KAFB) and the U.S. Forest Service Withdrawn Area (Figure 1-1). This inactive site was identified as the Workman Site in the Module IV Resource Conservation and Recovery Act (RCRA) Part B Permit (Hazardous and Solid Waste Amendment Module). The past activities at this site are associated with development of the proximity fuze, a radar-activated, variable-timed, bomb fuze used in antiaircraft defense munitions. ER Site 57B was the target area for antiaircraft artillery shells fired from the Workman Firing Site (ER Site 57A), 2 miles to the west.

ER Site 57B contained dry-cell battery debris, the remains of two 300-foot tall, triangular-shaped wood towers, and two possible blast pits (Figure 1-2). The tower remnants included concrete footings with steel tower supports, abundant burned wood, and numerous large metal bolts and fasteners. The tower debris was mainly scattered between and concentrated at, the tower bases. Two small metal and one wood equipment boxes were mounted on poles located between the tower bases. Weathered dry-cell battery packs were scattered on the ground by these boxes and at the south tower base. Two pits east of the north tower base appear to be blast pits because of their conical shapes. A debris mound of demolition rubble extends for about 700 feet along west side of the site. Debris in the mound includes wire, cable, concrete (including cut concrete and rebar), asphalt, and granite boulders.

The proximity fuze development activities associated with the Workman sites took place from 1942 and 1948. Artillery was fired from Site 57A at targets suspended between the two former towers at ER Site 57B. Aerial photos show the towers and two pits were already in place by 1951 (USGS 1951). The utility boxes are not evident on any of the aerial photos between 1951 and 1991, probably because of their small size. The demolition rubble mound was constructed between 1975 and 1983 (USGS 1971, USDA 1983). Based on aerial photo review, no more rubble was added to the mound after 1983 (IT Corporation April 1994).

ER Site 57B lies in the Mount Washington drainage basin that extends west from the nearby Manzanita Mountains. The site covers approximately 11.13 acres, slopes gently west, and has an average elevation of 5,959 feet above mean sea level (SNL/NM April 1994). The surface geology consists of a thin veneer of aeolian deposits underlain by alluvial fan deposits. The alluvial deposits belong to the Tijeras gravelly fine sandy loam association (IT Corporation May 1994). The thickness of these sediments is unknown, but a small hill of Precambrian metarhyolite(?) outcrops just south of the site (GRAM Inc. December 1995). The future land use is industrial (DOE and USAF 1995).

Depth to groundwater at ER Site 57B is unknown but is estimated at between 124 and 220 feet below grade. Groundwater was encountered in fractured, decomposed granite 124 feet below grade in the Optical Range well, approximately 1,800 feet north of ER Site 57B. Borings at the Albuquerque Seismological Laboratory approximately 2,300 feet due south of ER Site 57B on the Isleta Indian Reservation encountered groundwater at a depth of about 220 feet below grade.

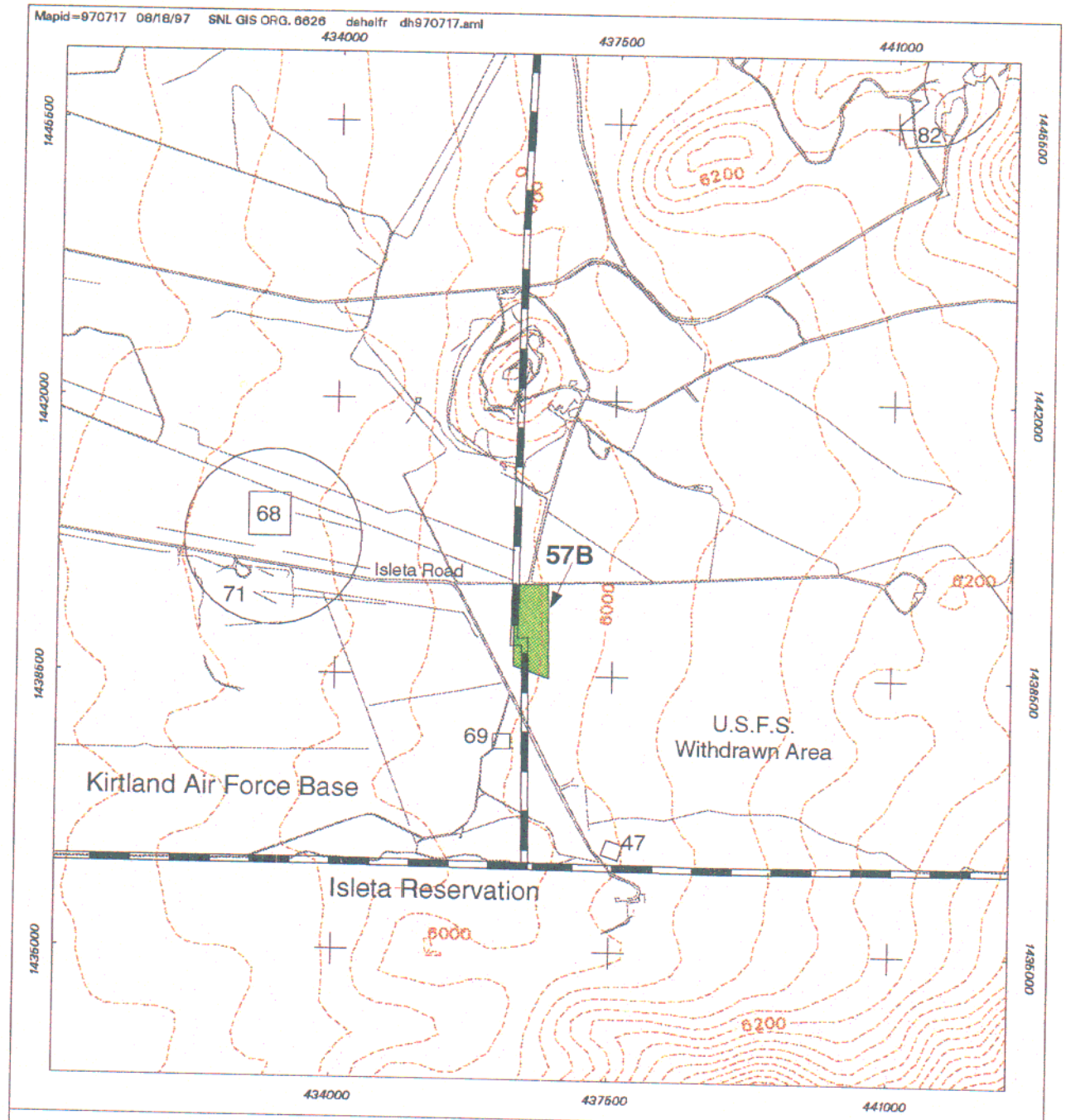
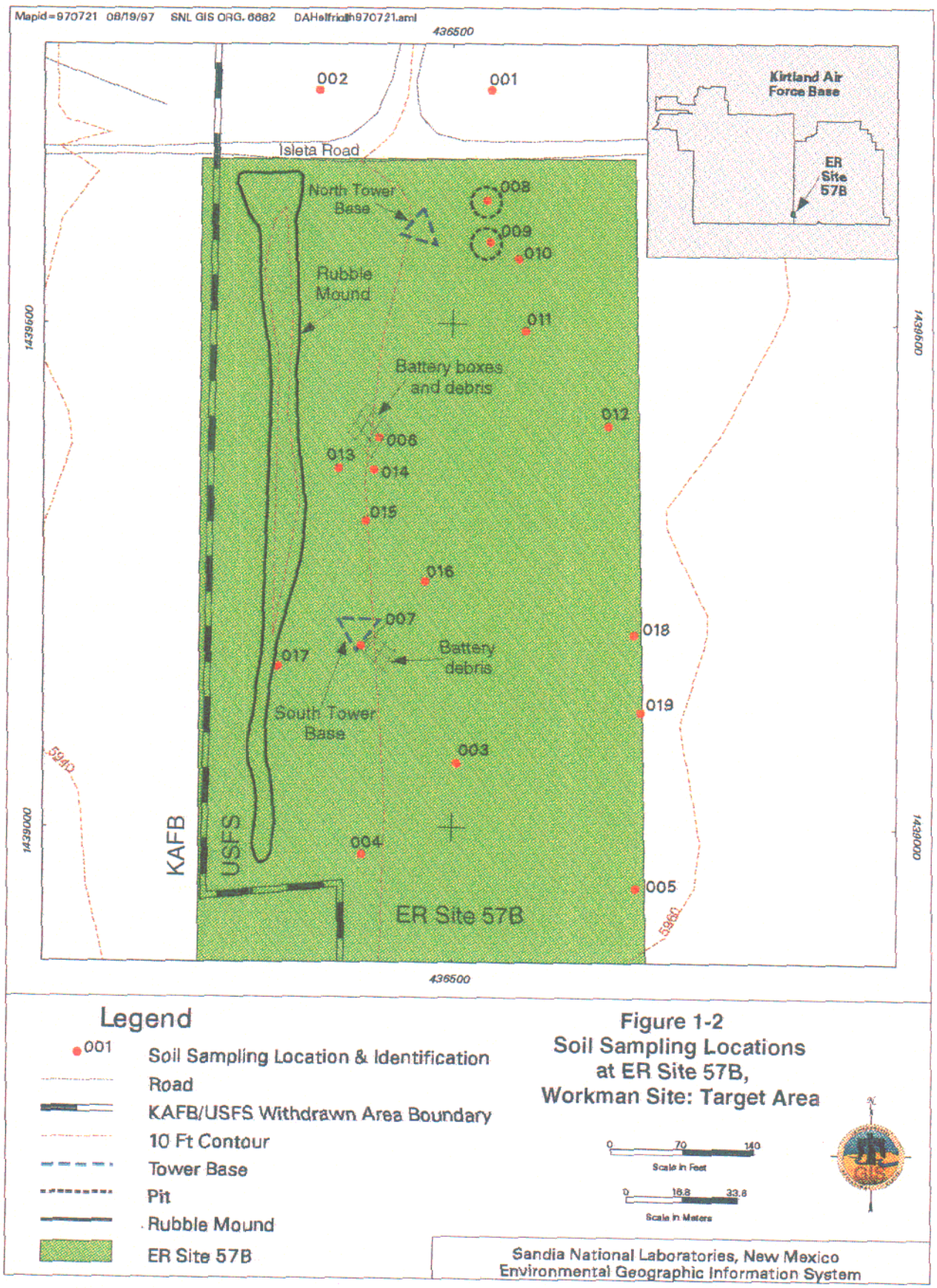


Figure 1-1
Location of ER Site 57B
Workman Site: Target Area


Mapid=970721 08/19/97 SNL GIS ORG. 6882 DAHelfrich970721.aml
436500
002
001
Kirtland Air Force Base
ER Site 57B
Isleta Road
North Tower Base
008
009
010
Rubble Mound
011
Battery boxes and debris
012
006
013
014
015
016
007
018
017
Battery debris
019
South Tower Base
003
1439600
1439500
1439000
KAFB
USFS
004
005
ER Site 57B
5940
5960
436500
Legend
001 Soil Sampling Location & Identification
Road
KAFB/USFS Withdrawn Area Boundary
10 Ft Contour
Tower Base
Pit
Rubble Mound
ER Site 57B
Figure 1-2
Soil Sampling Locations
at ER Site 57B,
Workman Site: Target Area
0 70 140
Scale in Feet
0 16.8 33.6
Scale in Meters
N
GIS
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

For a detailed discussion of the local setting of ER Site 57B, refer to the RCRA Facility Investigation (RFI) Work Plan for Operable Unit (OU) 1334 (SNL/NM October 1994).

1.2 No Further Action Basis

Review and analysis of all relevant data for ER Site 57B indicates that concentrations of constituents of concern (COC) are less than applicable risk assessment action levels. Thus, ER Site 57B is being proposed for a No Further Action (NFA) decision based on confirmatory sampling data demonstrating that COCs that may have been released from this Solid Waste Management Unit (SWMU) into the environment pose an acceptable level of risk under current and projected future land use per Criterion 5 of the ER Document of Understanding (DOU) (NMED 1996).

2.0 HISTORY OF ER SITE 57B

2.1 Historical Operations

The purpose of the testing at Sites 57A and B was to develop a fuze that would detonate an artillery shell near an intended target without having to actually hit it. This fuze, know as the "proximity fuze," was developed for the U.S. Navy during World War II. The proximity fuze work was conducted to develop a method of destroying Japanese kamikaze planes and for antiaircraft defense during the Battle of Britain. Fuze development activities took place from 1942 and 1948. Shells were fired from 3- and 5-inch diameter naval guns at Site 57A toward targets (old airplane fuselages, old cars, or chicken wire frames) suspended between two towers at ER Site 57B (Lojek and Sandhaus 1994). Observation shelters used during these tests are located in the range between the firing area (57A) and the target site (57B).

SNL/NM used the towers in 1956 for meteorological monitoring during the Project 56 (Moonlight Shot) testing at nearby ER Site 71. Between 1950 and 1962, SNL/NM conducted earth penetration tests in which 50-caliber or larger guns were fired from the top of the towers into the ground (Lojek and Sandhaus 1994).

2.2 Previous Audits, Inspections, and Findings

ER Site 57B was identified during investigations conducted under the Comprehensive Environmental Assessment and Response Program (CEARP) (DOE 1987) and the RCRA Facility Assessment (RFA) (EPA 1987). The CEARP investigation reported that the military conducted a cleanup of the site in the early 1980s, but no supporting records have been located. The RFA determined that the Workman Site did not meet the regulatory definition of an SWMU; nevertheless, a hazardous source may be present at the site (DOE 1987, EPA 1987).

3.0 EVALUATION OF RELEVANT EVIDENCE

3.1 Unit Characteristics and Operating Practices

The towers were razed before the mid-1980s because their deteriorated condition made them a safety hazard (Lojek and Sandhaus 1994). In April 1995, SNL/NM removed the dry-cell battery debris from the site as a voluntary corrective measure (VCM). Another VCM in March 1997 removed the equipment boxes, metal bolts and fasteners, and scrap lumber. Approximately 20 cubic yards of material was removed and disposed of as nonhazardous waste. The site is currently inactive.

3.2 Results of SNL/NM ER Project Sampling/Surveys

3.2.1 Summary of Prior Investigations

The following sources of information, presented in chronological order, were used to evaluate ER Site 57B:

- Historical aerial photographs (1951 through 1991)
- Interviews of SNL/NM personnel (1993)
- Unexploded ordnance (UXO)/high explosive (HE) and metal detector survey (1993)
- Surface radiation anomaly surveys (1993, 1994)
- Results of an archeological/cultural resources survey (Hoagland and Dello-Russo 1995) and a sensitive- or special-status species or environment survey (IT Corporation February 1995)
- SNL/NM scoping sampling of surface soils (June 1995)
- SNL/NM RFI sampling of surface soils (June, December 1996)
- Photographs and field notes collected at the site by SNL/NM staff.

3.2.2 UXO/HE Survey

In December 1993, KAFB conducted a surface visual UXO/HE survey of ER Site 57B. No live UXO/HE or significant UXO/HE debris was found during this survey (Young 1993).

3.2.3 Radiological Surveys

In November 1993, SNL/NM Radiation Protection Operations (RPO) personnel conducted a beta/gamma radiation survey at the site with Geiger-Mueller and sodium iodide detectors. All survey readings were approximately at background (SNL/NM October 1994). A second gamma-scan survey was conducted in March 1994 as part of the Phase I surface radiation survey (SNL/NM 1997). Four area sources were identified, all associated with the debris mound on the west boundary of the site. Subsequent gamma spectroscopy analysis of soil samples collected at those locations indicated they are related to naturally occurring geologic material (SNL/NM 1997).

3.2.4 Cultural-Resources Survey

No cultural-resource concerns were identified during the survey of ER Site 57B (Hoagland and Dello-Russo 1995).

3.2.5 Sensitive-Species Survey

Although the undisturbed areas of ER Site 57B appeared to be suitable habitat for gramma grass cacti and possibly visnagita cacti, no sensitive species were observed at the site during a survey in September 1994 (IT Corporation February 1995).

3.2.6 Voluntary Corrective Measures

Two VCMs were performed at ER Site 57B. In April 1995, the battery debris was removed from the area near the equipment boxes (Figure 1-2). In March 1997, the equipment boxes along with the burned wood, metal bolts and fasteners scattered across the site were removed.

3.2.7 Scoping Sampling

On June 15, 1995, SNL/NM conducted scoping sampling at ER Site 57B. Surface (0 to 0.5 foot) soil samples were collected at four locations and analyzed for total petroleum hydrocarbons (TPH), HE, RCRA metals plus beryllium, and radionuclides (gamma spectroscopy). TPH was analyzed using an immunoassay kit. HE, RCRA metals plus beryllium, and radionuclide analyses were performed by SNL/NM on-site laboratories. Samples were field-screened for the presence of volatile organic compounds (VOC) using a photoionization detector (PID) and for beta-gamma radiation using a pancake probe.

Samples were collected at the southern site boundary, the southern blast pit, the battery debris location near the equipment boxes, and the battery debris location near the south tower base. No TPH, HE, or radionuclides above background concentrations were detected in any sample. Barium concentrations ranged from <10 milligrams per kilogram (mg/kg) in the south tower base sample to a maximum of 150 mg/kg in the sample from the site boundary. Lead (200 mg/kg) and chromium (95 mg/kg) were detected in the sample from the south tower base. Lead (47 mg/kg), chromium (11 mg/kg), and mercury (0.21 J mg/kg) were detected in the

sample near the equipment boxes. Both of these samples contained battery debris, according to the field notes.

The purposes of the scoping sampling effort were to obtain preliminary analytical data to support the ER Project site ranking and prioritization and to focus any subsequent characterization efforts at the site. No quality assurance (QA)/quality control (QC) samples were collected.

3.2.8 Confirmatory Sampling

On June 13 and 14, 1996, SNL/NM collected soil samples from 19 locations at ER Site 57B (Figure 1-2). Samples were collected at 2 background locations, the 2 former battery debris locations, the 2 pits, and 13 other locations distributed across the site as described in the OU 1334 RFI Work Plan (SNL/NM October 1994). Samples were analyzed for HE and RCRA metals plus beryllium. Five locations were also sampled for gamma spectroscopy analyses and isotopic uranium and thorium.

Sampling was again conducted in December 1996 because the holding times for HE were missed. Seven samples and one duplicate were collected and submitted for analysis. These samples were also analyzed beyond the holding time, although laboratory records did not indicate this until very recently. All data from both sampling events are provided for comparison.

Soil samples were collected at depths of 0 to 0.5 and 0.5 to 1.0 feet below grade, in accordance with ER Field Operating Procedure (FOP) 94-52, using standard equipment (stainless steel bowl, trowel, etc.) and standard decontamination procedures, in accordance with ER FOP 94-57. The samples were managed in accordance with ER FOP 94-34. Samples were sent to both on-site and off-site laboratories for analysis. Splits of 10 percent of the HE and RCRA metals plus beryllium samples were sent to an off-site laboratory. All isotopic uranium and thorium samples also went to an off-site laboratory.

Sample analyses were conducted at both on-site and off-site laboratories in accordance with standard U.S. Environmental Protection Agency (EPA) Methods: EPA Method 6010/7000 for RCRA metals plus beryllium, EPA Method 8330 or equivalent on-site High-Pressure Liquid Chromatography (HPLC) or Micellar Electrokinetic Capillary Chromatography (MEKC) techniques for HE. Gamma spectroscopy analyses were performed at the SNL/NM Radiation Protection Sample Diagnostics Laboratory. Isotopic uranium and thorium analyses were performed off site using alpha spectroscopy techniques. All samples were field-screened for organic compounds and radioactivity using both a PID and a beta-gamma (pancake) probe, respectively. No elevated PID or beta-gamma readings were observed in any of the soil samples.

Analytical results for both on-site and off-site laboratories are summarized in the following sections.

Metals

On-site analytical results for RCRA metals plus beryllium are presented in Table 3-1. Off-site analytical results for the sample splits are presented in Table 3-2.

Silver: Silver was not detected in any samples analyzed on site at concentrations equal to or exceeding the 1.7 mg/kg method detection limit (MDL) (Table 3-1). Even though the MDL exceeded the New Mexico Environment Department (NMED) Oversight Bureau (OB) maximum recommended concentration of <0.5 mg/kg, the fact that no silver was detected in any of the off-site splits (<0.20 mg/kg MDL) indicates that silver is not present at the site (Table 3-2).

Arsenic: Arsenic was detected at concentrations above the MDL and in excess of the NMED-OB recommended maximum background concentration of 9.8 mg/kg in 5 of 41 samples analyzed on site and in 2 split samples analyzed off site (Tables 3-1 and 3-2). The highest concentration (42 J mg/kg) was detected at location 016 near the center of the site. The 30 J mg/kg concentration measured in one battery debris location sample (location 006, Figure 1-2) is probably not associated with a release since a similar concentration was not measured in the other battery debris area sample (location 007) and the same levels of arsenic were detected at locations with no battery debris (locations 003, 004, 013). The elevated arsenic concentrations may be naturally-occurring.

Barium: Barium was not detected in any samples at concentrations exceeding the NMED-OB recommended maximum background concentration of 246 mg/kg (Tables 3-1 and 3-2).

Beryllium: Beryllium was not detected in any samples at concentrations exceeding the NMED-OB recommended maximum background concentration of 0.75 mg/kg (Tables 3-1 and 3-2).

Cadmium: Cadmium was not detected in any samples analyzed on site at concentrations equal to or exceeding the 2.1 mg/kg MDL (Table 3-1). Even though the MDL exceeded the NMED-OB maximum recommended concentration of 0.64 mg/kg, the fact that no cadmium was detected in any of the off-site splits (<0.60 mg/kg MDL) indicates that cadmium is not present at the site (Table 3-2).

Chromium: Chromium was not detected in any samples at concentrations exceeding the NMED-OB recommended maximum background concentration of 18.8 mg/kg (Tables 3-1 and 3-2).

Lead: Lead was detected at concentrations above the NMED-OB maximum recommended concentration of 18.9 mg/kg in six samples analyzed on-site and in all samples analyzed off-site (Tables 3-1 and 3-2). The maximum on-site laboratory detection (34 mg/kg) was at location 009, in the bottom of the southern pit (Figure 1-2). The sample collected from the battery debris area near the south tower base, location 007, contained 30 mg/kg lead. The scoping study sample from this area contained 200 mg/kg of lead (Section 3.2.7).

Table 3-1
Summary of ER Site 57B Soil Sampling On-Site Laboratory Analytical Results, June 1996
RCRA Metals plus Beryllium

Sample Attributes				Metals (EPA 6010/7000; concentrations in mg/kg)								
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	Ag	As	Ba	Be	Cd	Cr	Pb	Se	Hg
030024-01	6-13-96	CCTA-57B-GR-001-0-0.5-S	0-0.5	<1.7	<26	150	<0.11	<2.1	<5	13 J	<50	<0.06
030025-01	6-13-96	CCTA-57B-GR-001-0.5-1.0-S	0.5-1.0	<1.7	<26	150	<0.11	<2.1	<5	7.6 J	58 J	<0.06
030026-01	6-13-96	CCTA-57B-GR-002-0-0.5-S	0-0.5	<1.7	<26	170	<0.11	<2.1	<5	7.5 J	<50	<0.06
030027-01	6-13-96	CCTA-57B-GR-002-0.5-1.0-S	0.5-1.0	<1.7	<26	150	<0.11	<2.1	<5	<3.4	55 J	<0.06
030028-01	6-13-96	CCTA-57B-GR-003-0-0.5-S	0-0.5	<1.7	36 J	91	<0.11	<2.1	<5	8.8 J	<50	<0.06
030029-01	6-13-96	CCTA-57B-GR-003-0.5-1.0-S	0.5-1.0	<1.7	<26	100	<0.11	<2.1	5 J	<3.4	50 J	<0.06
030030-01	6-13-96	CCTA-57B-GR-004-0-0.5-S	0-0.5	<1.7	39 J	190	<0.11	<2.1	<5	31	<50	<0.06
030031-01	6-13-96	CCTA-57B-GR-004-0.5-1.0-S	0.5-1.0	<1.7	<26	160	<0.11	<2.1	<5	16	<50	<0.06
030032-01	6-13-96	CCTA-57B-GR-005-0-0.5-S	0-0.5	<1.7	<26	150	<0.11	<2.1	<5	31	78 J	<0.06
030033-01	6-13-96	CCTA-57B-GR-005-0.5-1.0-S	0.5-1.0	<1.7	<26	130	<0.11	<2.1	<5	7.7 J	55 J	<0.06
030034-01	6-13-96	CCTA-57B-GR-006-0.5-1.0-S	0.5-1.0	<1.7	30 J	110	<0.11	<2.1	<5	13 J	<50	<0.06
030035-01	6-13-96	CCTA-57B-GR-007-0.5-1.0-S	0.5-1.0	<1.7	<26	140	<0.11	<2.1	<5	30	<50	<0.06
030036-01	6-13-96	CCTA-57B-GR-008-0-0.5-S	0-0.5	<1.7	<26	190	<0.11	<2.1	11 J	10 J	<50	<0.06
030037-01	6-13-96	CCTA-57B-GR-009-0-0.5-S	0-0.5	<1.7	<26	150	<0.11	<2.1	<5	34	<50	<0.06
030038-01	6-13-96	*CCTA-57B-GR-009-0-0.5-SD (Duplicate Sample)*	0-0.5	<1.7	<26	140	<0.11	<2.1	<5	10 J	<50	<0.06
030039-01	6-13-96	CCTA-57B-GR-010-0-0.5-S	0-0.5	<1.7	<26	130	<0.11	<2.1	<5	26	<50	<0.06
030040-01	6-13-96	CCTA-57B-GR-010-0.5-1.0-S	0.5-1.0	<1.7	<26	170	<0.11	<2.1	<5	26	<50	<0.06
030042-01	6-14-97	CCTA-57B-GR-011-0-0.5-S	0-0.5	<1.7	<26	110	<0.11	<2.1	<5	6.5 J	<50	0.26
030043-01	6-14-97	CCTA-57B-GR-011-0.5-1.0-S	0.5-1.0	<1.7	<26	160	<0.11	<2.1	<5	5.4 J	75 J	0.24 J
030044-01	6-14-97	CCTA-57B-GR-012-0-0.5-S	0-0.5	<1.7	<26	130	<0.11	<2.1	<5	9.9 J	<50	0.32
030045-01	6-14-97	CCTA-57B-GR-012-0.5-1.0-S	0.5-1.0	<1.7	<26	100	<0.11	<2.1	5.3 J	<3.4	<50	0.24 J
030046-01	6-14-97	CCTA-57B-GR-013-0-0.5-S	0-0.5	<1.7	<26	78	<0.11	<2.1	<5	<3.4	<50	0.18 J
030047-01	6-14-97	CCTA-57B-GR-013-0.5-1.0-S	0.5-1.0	<1.7	28 J	120	<0.11	<2.1	<5	<3.4	<50	0.28
030048-01	6-14-97	CCTA-57B-GR-014-0-0.5-S	0-0.5	<1.7	<26	75	<0.11	<2.1	5.8 J	6.2 J	<50	<0.06
030049-01	6-14-97	CCTA-57B-GR-014-0.5-1.0-S	0.5-1.0	<1.7	<26	91	<0.11	<2.1	<5	<3.4	<50	<0.06
030050-01	6-14-97	CCTA-57B-GR-015-0-0.5-S	0-0.5	<1.7	<26	85	<0.11	<2.1	<5	<3.4	56 J	<0.06

Refer to footnotes at end of table.

Table 3-1 (Concluded)
Summary of ER Site 57B Soil Sampling On-Site Laboratory Analytical Results, June 1996
RCRA Metals plus Beryllium

Sample Attributes				Metals (EPA 6010/7000; concentrations in mg/kg)								
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	Ag	As	Ba	Be	Cd	Cr	Pb	Se	Hg
030051-01	6-14-97	CCTA-57B-GR-015-0.5-1.0-S	0.5-1.0	<1.7	<26	99	<0.11	<2.1	<5	5.2 J	<50	0.34
030052-01	6-14-97	*CCTA-57B-GR-015-0.5-1.0-SD (Duplicate Sample)*	0.5-1.0	<1.7	<26	120	<0.11	<2.1	<5	4.4 J	<50	<0.06
030053-01	6-14-97	CCTA-57B-GR-016-0-0.5-S	0-0.5	<1.7	42 J	110	<0.11	<2.1	<5	<3.4	<50	<0.06
030054-01	6-14-97	CCTA-57B-GR-016-0.5-1.0-S	0.5-1.0	<1.7	<26	120	<0.11	<2.1	8.5 J	<3.4	<50	<0.06
030055-01	6-14-97	CCTA-57B-GR-017-0-0.5-S	0-0.5	<1.7	<26	100	<0.11	<2.1	<5	4.6 J	<50	<0.06
030056-01	6-14-97	CCTA-57B-GR-017-0.5-1.0-S	0.5-1.0	<1.7	<26	120	<0.11	<2.1	<5	3.6 J	55 J	<0.06
030057-01	6-14-97	CCTA-57B-GR-018-0-0.5-S	0-0.5	<1.7	<26	65	<0.11	<2.1	5.3 J	6.4 J	62 J	0.15 J
030058-01	6-14-97	CCTA-57B-GR-018-0.5-1.0-S	0.5-1.0	<1.7	<26	144	<0.11	<2.1	<5	17	<50	<0.06
030059-01	6-14-97	*CCTA-57B-GR-018-0.5-1.0-SD (Duplicate Sample)*	0.5-1.0	<1.7	<26	130	<0.11	<2.1	<5	14	<50	<0.06
030060-01	6-14-97	CCTA-57B-GR-019-0-0.5-S	0-0.5	<1.7	<26	65	<0.11	<2.1	8.7 J	<3.4	<50	<0.06
029101-01	6-14-97	CCTA-57B-GR-019-0.5-1.0-S	0.5-1.0	<1.7	<26	90	<0.11	<2.1	8.8 J	6.3 J	<50	<0.06
		Canyons Maximum Background Concentration (mg/kg)[a]	NA	**<0.5**	**9.8**	**246**	**0.75**	**0.64**	**18.8**	**18.9**	**3.0**	**0.055**
Quality Assurance/Quality Control Samples (all in mg/L)												
030041-01	6-13-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<0.017	<0.26	<0.1	<0.0011	<0.021	<0.05	<0.0034	<0.5	<0.0002
029102-01	6-14-97	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<0.017	<0.26	<0.1	<0.0011	<0.021	<0.05	<0.034	<0.05	<0.0002

[a]Maximum Background Concentrations are those suggested by the New Mexico Environment Department Oversight Bureau (IT Corporation 1996).
Metals: **As** = arsenic; **Ba** = barium; **Be** = beryllium; **Cd** = cadmium; **Cr** = chromium; **Pb** = lead; **Hg** = mercury; **Se** = selenium; **Ag** = silver.
mg/kg - Milligrams per kilogram.
mg/L - Milligrams per liter.
NA - Not applicable.
ND - Not detected at the MDL.
UTL - upper tolerance limit.

Table 3-2
Summary of ER Site 57B Soil Sampling Off-Site Laboratory Analytical Results, June 1996
RCRA Metals plus Beryllium; High Explosives

Sample Attributes				Metals (EPA 6010/7000; concentrations in mg/kg)									High Explosives
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	Ag	As	Ba	Be	Cd	Cr	Pb	Se	Hg	(EPA 8330, µg/kg)
030028-01	6-13-97	CCTA-57B-GR-003-0-0.5-S	0-0.5	<0.20	3.8	120	0.59 J	<0.59	15	25	<0.79	<0.091 UJ^	NA
030033-01	6-13-97	CCTA-57B-GR-005-0.5-1.0-S	0.5-1.0	<0.20	4.6	170	0.69 J	<0.60	18	29	<0.80	<0.091 UJ^	NA
030039-01	6-13-97	CCTA-57B-GR-010-0-0.5-S	0-0.5	<0.20	5.8	150	0.62 J	<0.59	15	21	<0.79	<0.095 UJ^	ND
030045-01, -04	6-14-96	CCTA-57B-GR-012-0.5-1.0-S	0.5-1.0	<0.20	5.9	160	0.67 J	<0.60	17	22	<0.79	<0.095 A, UJ	ND
030050-01, -04	6-14-96	CCTA-57B-GR-015-0-0.5-S	0-0.5	<0.20	4.6	130	0.58 J	<0.60	16	20	<0.80	<0.10 A, UJ	ND
030056-01, -04	6-14-96	CCTA-57B-GR-017-0.5-1.0-S	0.5-1.0	<0.20	5.4	150	0.65 J	<0.60	16	23	0.90 J	<0.083 A, UJ	ND
030060-01, -04	6-14-96	CCTA-57B-GR-019-0-0.5-S	0-0.5	<0.20	4.1	130	0.69 J	<0.60	18	19	<0.81	<0.091 A, UJ	ND
		Canyons Maximum Background Concentration (mg/kg)*	**NA**	**<0.5**	**9.8**	**245**	**0.75**	**0.64**	**16.8**	**18.9**	**3.0**	**0.055**	NA
Quality Assurance/Quality Control Sample (in mg/L)													
029102-01, -04	6-14-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<0.0010	<0.0030	<0.0010	<0.0010	<0.0030	<0.0040	<0.0020	<0.0040	<0.00020 A, UJ	ND

*Maximum Background Concentrations are those suggested by the New Mexico Environment Department Oversight Bureau (IT Corporation 1996).
A - Laboratory accuracy does meet requirments.
Metals: **As** = arsenic; **Ba** = barium; **Be** = beryllium; **Cd** = cadmium; **Cr** = chromium; **Pb** = lead; **Hg** = mercury; **Se** = selenium; **Ag** = silver.
mg/kg - Milligrams per kilogram.
mg/L - Milligrams per liter.
NA - Not applicable.
ND - Not detected at the MDL.
UJ - The material was not detected. The associated value is an estimate and may be greater than indicated.
^ - Relative percent difference for duplicate analysis exceeded acceptance limits.

Selenium: Selenium was detected in 9 of 41 samples analyzed on site at concentrations exceeding the NMED-OB maximum recommended concentration of 3.0 mg/kg (Tables 3-1 and 3-2). The 0.5- to 1.0-foot samples from the background locations (locations 001 and 002, Figure 1-2) contained 58 J and 55 J mg/kg selenium, respectively, indicating that these elevated concentrations may be naturally occurring at this site.

Mercury: The MDL for soil analyses at both on-site and off-site laboratories exceeded the NMED-OB recommended maximum background concentration of 0.055 mg/kg. Mercury (ranging from 0.18 J to 0.34 mg/kg) was detected in eight samples from locations 011, 012, 013, 015, and 018 (Table 3-1, Figure 1-2). There is no obvious relationship between these sample locations and site features or activities. Samples from locations 013 and 015 were collected in the vicinity of one battery debris area, but the samples taken at the battery debris locations (006 and 008) did not contain detectable concentrations of mercury (Table 3-1). There were no mercury detections above the MDL in the seven samples analyzed off-site (Table 3-2).

High Explosives

No HE compounds were detected in soil samples collected in June 1996. However, the on-site samples were analyzed beyond the holding time (Table 3-3). Seven locations were resampled in December 1996 (Table 3-4), and again no HE compounds were detected. It was only recently that the laboratory identified that these samples were also analyzed beyond the holding time. Since no HE compounds were detected in the off-site split samples (Table 3-2), it is likely that the on-site analyses are still representative, and HE compounds are actually not present in soil at ER Site 57B.

Radionuclides

On-site laboratory analytical results for gamma spectroscopy analyses are shown in Table 3-5. Off-site analytical results for isotopic uranium and isotopic thorium analyses are shown in Table 3-6. No elevated beta-gamma readings were observed using a Geiger-Mueller detector with a pancake probe to field-screen samples during field activities.

The anticipated radiological contaminant of concern at ER Site 57B was depleted uranium (DU, uranium [U]-238). No U-238 concentrations or short-lived daughter product (thorium [Th]-234) activities above Canyons Area background values (which includes ER Site 57B) were detected in these soil samples (Table 3-5). The minimum detectable activity (MDA) for U-235 analyses was greater than the SNL/NM 95th percentile activity of 0.16 picocuries per gram (pCi/g) (IT Corporation March 1996) (for all but one analysis), but the absence of the U-238 above background, which would be accompanied by trace amounts of U-235 if DU contamination existed on the site, indicates that there are no elevated U-235 concentrations in these samples. The Th-234 activities were below the SNL/NM 95th percentile activity of 2.31 pCi/g (IT Corporation March 1996). Several Th-232 and radium (Ra)-228 activities are slightly elevated above the SNL/NM 95th percentile values for the Canyons Area (IT Corporation March 1996), so a radiological risk assessment was performed.

Table 3-3
Summary of ER Site 57B Soil Sampling On-Site Laboratory Analytical Results, June 1996
High Explosives by High Pressure Liquid Chromatography

Sample Attributes				High Explosives (concentrations in µg/kg)				
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	TNT	RDX	HMX	PETN	Nitroglycerine
030036-04	6-13-96	CCTA-57B-GR-008-0-0.5-S	0-0.5	<76	<150	<100	<150	<30
030037-04	6-13-96	CCTA-57B-GR-009-0-0.5-S	0-0.5	<76	<150	<100	<150	<30
030038-04	6-13-96	*CCTA-57B-GR-009-0-0.5-SD (Duplicate Sample)*	0-0.5	<76	<150	<100	<150	<30
030039-04	6-13-96	CCTA-57B-GR-010-0-0.5-S	0-0.5	<76	<150	<100	<150	<30
030040-04	6-13-96	CCTA-57B-GR-010-0.5-1.0-S	0.5-1.0	<76	<150	<100	<150	<30
030042-04	6-14-96	CCTA-57B-GR-011-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030043-04	6-14-96	CCTA-57B-GR-011-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030044-04	6-14-96	CCTA-57B-GR-012-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030045-09	6-14-96	CCTA-57B-GR-012-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030046-04	6-14-96	CCTA-57B-GR-013-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030047-04	6-14-96	CCTA-57B-GR-013-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030048-04	6-14-96	CCTA-57B-GR-014-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030049-04	6-14-96	CCTA-57B-GR-014-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030050-09	6-14-96	CCTA-57B-GR-015-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030051-04	6-14-96	CCTA-57B-GR-015-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030052-04	6-14-96	*CCTA-57B-GR-015-0.5-1.0-SD (Duplicate Sample)*	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030053-04	6-14-96	CCTA-57B-GR-016-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030054-04	6-14-96	CCTA-57B-GR-016-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030055-04	6-14-96	CCTA-57B-GR-017-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
030056-09	6-14-96	CCTA-57B-GR-017-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030057-04	6-14-96	CCTA-57B-GR-018-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H

Refer to footnotes at end of table

Table 3-3 (Concluded)
Summary of ER Site 57B Soil Sampling On-Site Laboratory Analytical Results, June 1996
High Explosives by High Pressure Liquid Chromatography

Sample Attributes				High Explosives (concentrations in µg/kg)				
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	TNT	RDX	HMX	PETN	Nitroglycerine
030058-04	6-14-96	CCTA-57B-GR-018-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030059-04	6-14-96	*CCTA-57B-GR-018-0.5-1.0-SD (Duplicate Sample)*	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
030060-09	6-14-96	CCTA-57B-GR-019-0-0.5-S	0-0.5	<76 H	<150 H	<100 H	<150 H	<30 H
029101-04	6-14-96	CCTA-57B-GR-019-0.5-1.0-S	0.5-1.0	<76 H	<150 H	<100 H	<150 H	<30 H
Quality Assurance/Quality Control Samples (all in µg/L)								
030041-04	6-13-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<76	<150	<100	<150	<30
029102-04	6-14-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<76 H	<150 H	<100 H	<150 H	<30 H

H - sample analyzed beyond holding time.
NA - Not applicable.
µg/kg - Micrograms per kilogram.
µg/L - Micrograms per liter.

Table 3-4
Summary of ER Site 57B Soil Resampling On-Site Laboratory Analytical Results, June 1996
High Explosives by Micellar Electrokinetic Capillary Chromatography (MEKC)

Sample Attributes				High Explosives (MEKC, concentrations in µg/kg)								
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	2,4,6-Trinitro-toluene	2,4-Dinitro-toluene	2,6-Dinitro-toluene	2-Nitro-toluene	3-Nitro-toluene	4-Nitro-toluene	HMX	PETN	RDX
NA	12-4-96	CCTA-57B-GR-001-0-0.5-S	0-0.5	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	CCTA-57B-GR-008-0-0.5-S	0-0.5	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	CCTA-57B-GR-009-0-0.5-S	0-0.5	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	*CCTA-57B-GR-009-0-0.5-SD (Duplicate Sample)*	0-0.5	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	CCTA-57B-GR-015-0-0.5-S	0-0.5	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	CCTA-57B-GR-015-0.5-1.0-S	0.5-1.0	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	CCTA-57B-GR-018-0-0.5-S	0-0.5	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
NA	12-4-96	CCTA-57B-GR-018-0.5-1.0-S	0.5-1.0	<120 H	<120 H	<120 H	<90 H	<100 H	<100 H	<150 H	<70 H	<110 H
Quality Assurance/Quality Control Sample (in µg/L)												
NA	12-4-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<18 H	<31 H	<56 H	<51 H	<40 H	<39 H	<45 H	<179 H	<60 H

H - Samples analyzed beyond holding time.
NA - Not Applicable.
µg/kg - Micrograms per kilogram.
µg/L - Micrograms per liter.

Table 3-5
Summary of ER Site 57B Soil Sampling On-Site Laboratory Analytical Results, June 1996
Gamma Spectroscopy

Sample Attributes				Gamma Spectroscopy (pCi/g)					
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	U-238	U-235	Th-234	Th-232	Ra-228	Cs-137
030024-05	6-13-96	CCTA-57B-001-0-0.5-S	0-0.5	<1.04	<0.228	1.32 ± 0.419	1.04 ± 0.518	0.984 ± 0.286	0.773 ± 0.380
030025-05	6-13-96	CCTA-57B-001-0.5-1.0-S	0.5-1.0	<1.01	<0.232	<0.710	0.973 ± 0.471	1.13 ± 0.529	0.298 ± 0.0609
030026-05	6-13-96	CCTA-57B-002-0-0.5-S	0-0.5	<1.56	<0.212	1.46 ± 0.425	1.08 ± 0.599	1.05 ± 0.261	<0.0438
030027-05	6-13-96	CCTA-57B-002-0.5-1.0-S	0.5-1.0	<1.49	<0.209	1.23 ± 0.375	1.04 ± 0.704	0.879 ± 0.241	<0.0402
030028-05	6-13-96	CCTA-57B-003-0-0.5-S	0-0.5	<1.46	<0.196	<0.609	1.01 ± 0.486	1.03 ± 0.252	0.347 ± 0.0771
030029-05	6-13-96	CCTA-57B-003-0.5-1.0-S	0.5-1.0	<0.869	<0.200	1.03 ± 0.643	1.04 ± 0.158	1.12 ± 0.309	0.0444 ± 0.0474
030030-05	6-13-96	CCTA-57B-004-0-0.5-S	0-0.5	<1.26	0.125 ± 0.0999	<0.0704	1.19 ± 0.566	1.18 ± 0.467	0.777 ± 0.126
030031-05	6-13-96	CCTA-57B-004-0.5-1.0-S	0.5-1.0	<1.51	<0.200	0.824 ± 0.378	1.03 ± 0.490	0.883 ± 0.286	0.193 ± 0.0785
030032-05	6-13-96	CCTA-57B-005-0-0.5-S	0-0.5	<1.45	<0.201	1.02 ± 0.384	0.934 ± 0.486	0.986 ± 0.278	0.387 ± 0.0807
030033-05	6-13-96	CCTA-57B-005-0.5-1.0-S	0.5-1.0	1.15 ± 1.88	<0.203	0.570 ± 0.362	0.976 ± 0.475	0.972 ± 0.268	0.0753 ± 0.0275
		SNL/NM 95th percentile/UTL (pCi/g)[a]	NA	**2.31**	**0.16**	**2.31**	**1.03**	**1.08**	**1.063**
Quality Assurance/Quality Control Sample (in pCi/L)									
030041-05	6-13-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	<0.760	<0.118	<0.312	<0.142	<0.137	<0.0215

[a]Values from IT Corporation 1996.
pCi/g - Picocuries per gram.
pCi/L - Picocuries per liter.

Table 3-6
Summary of ER Site 57B Soil Sampling Off-Site Laboratory Analytical Results, June 1996
Isotopic Uranium and Thorium by Alpha Spectoscopy

Sample Attributes				Alpha Spectroscopy (pCi/g)					
Sample Number	Sample Date	ER Sample ID	Sample Depth (ft)	U-238	U-235	U-233/234	Th-228	Th-230	Th-232
030024-02, -03	6-13-96	CCTA-57B-001-0-0.5-S	0-0.5	0.920 ± 0.095	0.040 ± 0.018	0.913 ± 0.094	1.11 ± 0.12	1.13 ± 0.11	1.07 ± 0.11
030025-02, -03	6-13-96	CCTA-57B-001-0.5-1.0-S	0.5-1.0	0.992 ± 0.10	0.055 ± 0.021	0.953 ± 0.099	1.18 ± 0.13	1.14 ± 0.12	1.25 ± 0.12
030026-02, -03	6-13-96	CCTA-57B-002-0-0.5-S	0-0.5	0.865 ±0.095	0.050 ±0.021	0.878 ±0.096	1.22 ± 0.11	1.27 ± 0.11	1.17 ± 0.11
030027-02, -03	6-13-96	CCTA-57B-002-0.5-1.0-S	0.5-1.0	0.931 ± 0.099	0.061 ± 0.023	0.818 ± 0.092	1.13 ± 0.12	1.13 ± 0.11	1.09 ± 0.11
030028-02, -03	6-13-96	CCTA-57B-003-0-0.5-S	0-0.5	0.843 ± 0.094	0.028 ± 0.015	0.753 ±0.088	1.25 ± 0.12	0.923 ± 0.093	1.26 ± 0.11
030029-02, -03	6-13-96	CCTA-57B-003-0.5-1.0-S	0.5-1.0	0.699 ± 0.079	0.038 ± 0.017	0.707 ± 0.079	1.22 ± 0.12	0.861 ± 0.095	1.07 ± 0.11
030030-02, -03	6-13-96	CCTA-57B-004-0-0.5-S	0-0.5	0.884 ± 0.086	0.042 ± 0.016	0.803 ± 0.081	1.60 ± 0.31 QJ	1.22 ± 0.23 QJ	1.41 ± 0.25 QJ
030031-02, -03	6-13-96	CCTA-57B-004-0.5-1.0-S	0.5-1.0	0.843 ± 0.086	0.031 ± 0.014	0.759 ± 0.081	1.42 ± 0.14	1.22 ± 0.027	1.33 ± 0.022
030032-02, -03	6-13-96	CCTA-57B-005-0-0.5-S	0-0.5	0.748 ± 0.077	0.030 ± 0.014	0.716 ± 0.075	1.25 ± 0.13	1.12 ± 0.12	1.27 ± 0.13
030033-02, -03	6-13-96	CCTA-57B-005-0.5-1.0-S	0.5-1.0	0.814 ± 0.088 F	0.069 ± 0.023 F	0.711 ± 0.081 F	1.26 ± 0.14	1.09 ± 0.12	1.23 ± 0.13
		SNL/NM 95th percentile/UTL (pCi/g)[a]	NA	**2.31**	**0.16**	**2.31**	**1.08[b]**	**2.31**	**1.03**
Quality Assurance/Quality Control Sample (in pCi/L)									
030041-02, -03	6-13-96	CCTA-57B-000-EB (Aqueous Equipment Blank)	NA	0.024 ± 0.035 U	0.004 ± 0.014 U	0.075 ± 0.052	-0.062 ± 0.083 U	0.003 ± 0.024 U	-0.002 ± 0.018 U

[a]Values from IT Corporation 1996.
[b]Th-228 background assumed to be that of its parent nuclide Ra-228.
F - Full width half max exceeded the acceptance criteria.
QJ - The required quantitation limit was not met due to low yield. The result is estimated due to higher than expected uncertainty.
pCi/g - Picocuries per gram.
pCi/L - Picocuries per liter.
U - Sample recoveries were detected below the critical level.

Off-site isotopic uranium and thorium analyses showed no U-238, U-235, or U-233/234 activities greater than the SNL/NM 95th percentile values for the Southwest Test Area (IT Corporation March 1996). All Th-230 activities are less than the SNL/NM 95th percentile values for the Southwest Test and Canyons Areas assuming Th-230 background is the same as its parent radionuclide, U-234. Several Th-228 and Th-232 activities exceeded the Canyons Study Area values and not believed to be indicative of radiological contamination. However, to eliminate any uncertainties, a risk assessment was performed (Section 6.1).

3.2.9 Site-Specific Background Sampling

Soil samples were collected and analyzed from locations 001 and 002 (Figure 1-2) for site-specific background data for RCRA metals. Samples from locations 001 through 005 were also analyzed for radionuclides. The 001 and 002 locations were assumed to be far enough away from any known sources of contamination or human activity to provide adequate site-specific background data.

The RCRA metal analytical results indicate the area around ER Site 57B may have naturally occurring elevated concentrations of barium and selenium (Table 3-1). Gamma spectroscopy and isotopic analyses show slightly elevated Th-232 and Ra-228 activities, but this does not confirm the presence of radiological contamination associated with this site or area (Tables 3-5 and 3-6).

3.2.10 QA/QC Results

Equipment rinsate blanks were collected every day prior to sampling to evaluate the effectiveness of the decontamination process. No analytes were detected.

All off-site data underwent a Level III data validation by IT Corporation, Albuquerque, New Mexico. The data were qualified accordingly, and any problems are identified in this report.

3.3 Gaps in Information

The gaps in information for ER Site 57B included the nature of potential COCs and their extent in the debris, pits, and surface soil at the site.

The RFI focused on determining the nature and extent of possible contaminants under the former battery debris areas and in the blast pits. Additionally, samples were collected from the surrounding area to determine site-specific concentrations of metals and radionuclides for comparison. The soils were characterized during the RFI and the presence, absence, or distribution of metals, HE, and radionuclides at the site was determined. Thus, the question of types and distribution of possible contaminants was answered during the RFI sampling.

3.4 Risk Evaluation

3.4.1 Human Health Risk Assessment

ER Site 57B has been recommended for industrial land use (DOE March 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Section 6.1. Due to the presence of metals and radionuclides in concentrations and activities greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. Besides metals, any radionuclide compounds detected above their reporting limits and any radionuclide compounds either detected above background levels and/or MDAs were included in this assessment. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site soil. The Risk Assessment Report calculated the Hazard Index and excess cancer risk for both industrial land-use and residential land-use settings. The excess cancer risk from nonradioactive COCs and the radioactive COCs is not additive (EPA 1989).

In summary, the Hazard Index calculated for ER Site 57B nonradioactive COCs is 0.2 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental Hazard Index is 0.13. The excess cancer risk for ER Site 57B nonradiological COCs is $3x10^{-5}$ for an industrial land-use setting, which is at the low end of the suggested range of acceptable risk of 10^{-4} to 10^{-6} (EPA 1989). The incremental excess cancer risk for ER Site 57B is $2.4x10^{-5}$. The incremental total effective dose equivalent for radionuclides for an industrial land-use setting is 1.2 millirem per year (mrem/yr), which is well below the standard dose limit of 15 mrem/yr (40CFR196 1994). The incremental excess cancer risk for radionuclides is $2x10^{-5}$ for an industrial land-use scenario, which is much less than risk values calculated due to naturally occurring radiation and from intakes considered background concentration values.

3.4.2 Ecological Risk Assessment

Potential risks were indicated for all three ecological receptors at ER Site 57B; however, the use of the maximum measured soil concentration or one-half of the maximum detection limit to evaluate risk provided a conservative exposure scenario for the risk assessment and may not reflect actual site conditions. One-half detection limit values were used to evaluate risk for cadmium, silver, and HE compounds. Maximum measured soil concentrations for arsenic, chromium, mercury, and selenium exceeded their respective plant benchmark values. Hazard Quotients (HQs) greater than 1.0 were estimated for the deer mouse exposed to arsenic, selenium, hexahydro-1,3,5-trinitro-1,3,5-trazine (RDX), and dinitrobenzene. Selenium and mercury resulted in HQs greater than 1.0 for the burrowing owl. Due to insufficient toxicity data for most HE compounds, potential risk estimates could not be determined for the terrestrial plant or the burrowing owl. In addition, insufficient toxicity data were available to evaluate potential risk to birds exposed to beryllium or silver. Radionuclides were not predicted to be hazardous to ecological receptors.

Closer examination of the analytical data indicates that many of the hazardous concentrations are similar to those of the background samples. Therefore, overall ecological risks are expected to be very low.

4.0 RATIONALE FOR NO FURTHER ACTION DECISION

Based on field investigation data and the human health risk assessment analysis, an NFA decision is being recommended for ER Site 57B for the following reasons:

- No VOCs or radionuclides were detected during the field-screening program.
- No HE compounds were detected in any of the RFI samples.
- Several metals were detected at concentrations exceeding NMED-OB recommended background concentrations. However, similar concentrations were also detected in the site-specific background samples and indicate that elevated concentrations may be naturally occurring at ER Site 57B for some metals.
- There is no clear indication of radiological contamination.
- Risk assessments for human health do not show adverse effects under the future industrial land-use scenario.
- Risk assessments for ecological receptors indicate potential risks under a conservative scenario. However, many hazardous concentrations are similar to background values, and overall ecological risks are expected to be very low.

Based upon the evidence provided above, ER Site 57B is proposed for an NFA based on Criterion 5 of the ER DOU (NMED 1996).

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6.0 ANNEXES

6.1 Risk Assessment Report

Section 6.1
Risk Assessment Report

ER SITE 57B: RISK ASSESSMENT ANALYSIS

I. Site Description and History

Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Site 57B, the Workman Site: Target Area, is at the east end of Isleta Road on the boundary of Kirtland Air Force Base (KAFB) and the U.S. Forest Service Withdrawn Area. The past activities at this site are associated with development of the proximity fuze, a radar-activated, variable-timed, bomb fuze used in antiaircraft defense munitions. ER Site 57B was the target area for antiaircraft artillery shells fired from the Workman Firing Site (ER Site 57A), 2 miles to the west. Shells were fired from 3- and 5-inch diameter naval guns at ER Site 57A toward targets (old airplane fuselages, old cars, or chicken wire frames) suspended between two 300-foot tall towers at ER Site 57B. Additional SNL/NM activities at this site include meteorological monitoring from the towers in 1956 during the Project 56 (Moonlight Shot) testing at nearby ER Site 71 and earth penetration tests in which 50-caliber or larger guns were fired from the top of the towers into the ground. A low debris mound of construction rubble, approximately 700 feet long, was constructed along the west side of the site between 1975 and 1983.

The towers were razed before the mid-1980s because their deteriorated condition made them a safety hazard. Two housekeeping voluntary corrective measures (VCM) by SNL/NM removed burned wood, metals bolts, weathered dry-cell battery packs, and other debris from the site. The site is currently unused. The future land use is industrial.

II. Human Health Risk Assessment Analysis

The site risk assessment includes a number of steps, which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents of concern (COC) at the site. The steps to be discussed include:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.
Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.

Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) to determine whether further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties in the previous steps are discussed.

II.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 57B No Further Action Proposal. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC for the entire site. Maximum concentrations reported from on-site and off-site laboratories were combined into a single table to provide conservative risk calculations. Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated are high explosives and metals.

II.2 Step 2. Pathway Identification

ER Site 57B has been designated with a future land-use scenario of industrial (DOE and USAF 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for chemical COCs and inhalation for radiological COCs. The inhalation pathway for both chemicals and radionuclides is included because of the potential to inhale dust. No contamination at depth is suspected, and therefore no pathways to the groundwater are considered. Depth to groundwater at ER Site 57B is estimated at approximately 124 to 220 feet below ground surface. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

PATHWAY IDENTIFICATION

Chemical Constituents	Radionuclide Constituents
Soil ingestion	Soil ingestion
Inhalation (dust)	Inhalation (dust and volatiles)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment

process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from COCs at ER Site 57B were evaluated using a tiered approach. First, the maximum COC concentrations were compared to the SNL/NM background screening level for this area (IT Corporation 1997a). If a SNL/NM-specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) program (USGS 1994).

The maximum COC concentration was used in order to provide a conservative estimate of the associated risk. If any nonradiological COCs were above either the SNL/NM background screening levels or the USGS background value, all nonradiological COCs were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE orders.

Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity (MDA) were carried through the risk assessment at their maximum levels. This step is performed (rather than carrying the below-background radioactive COCs through the risk assessment and then performing a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs, the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a nonconservative estimate of the potential impact to an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196 1994), which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

Second, if any nonradiological COC failed the initial screening step, the maximum nonradiological COC concentration was compared with action levels calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. If there are ten or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than ten COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using reasonable maximum exposure (RME) methods and equations promulgated in RAGS (EPA 1989). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of the nonradiological COCs at their respective upper tolerance limit (UTL) or 95th percentile background concentration in the soil were also calculated. For toxic compounds, the combined effects were calculated by summing the individual hazard quotients for each compound into a total Hazard Index. This Hazard Index is compared to the recommended

guideline of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6}. For the radioactive COCs, the incremental TEDE was calculated and the corresponding incremental cancer risk estimated using DOE's RESRAD computer code.

II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 57B COCs are listed in Table 1, and radioactive COCs are listed in Table 2. All tables show the associated 95th percentile or UTL background levels (IT Corporation 1997a).

The SNL/NM background levels have not yet been approved by the EPA or the New Mexico Environment Department but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the KAFB. This report was submitted for regulatory review in early 1997. The values shown in Table 1 supersede the background values described in an interim background study report (IT Corporation 1996).

Several compounds have maximum measured values greater than background screening levels. Therefore, all nonradiological COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 34 milligrams per kilogram (mg/kg). The EPA intentionally does not provide any toxicological data on lead, and therefore no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA 1994). The maximum concentration value for lead at this site is less than both of those screening values, and therefore lead is eliminated from further consideration in this risk assessment.

Because several COCs did not have background screening values, all COCs proceed to the proposed Subpart S action level screening procedure. Because the ER Site 57B sample set had more than ten COCs that continued past the first screening level (including explosive compounds that do not have background screening concentrations), the proposed Subpart S screening process was skipped. All remaining COCs must have a Hazard Index value and cancer risk value calculated.

Radioactive contamination does not have predetermined action levels analogous to those proposed in Subpart S, and therefore this step in the screening process is not performed for radionuclides.

II.3.2 Identification of Toxicological Parameters

Tables 3 and 4 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCF) used in determining the excess TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed for the following:

Table 1
Nonradioactive COCs at ER Site 57B and Comparison to the Background Screening Values

COC Name	Maximum Concentration (mg/kg)	SNL/NM 95th % or UTL Level (mg/kg)	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?
Arsenic	42 J	9.8	No
Barium	190	246	Yes
Beryllium	0.69 J	0.75	Yes
Cadmium	1.1**	0.64	No
Chromium, total*	18	NC	NA
Lead	34	18.9	No
Mercury	0.34	0.055	No
Selenium	78 J	3.0	No
Silver	0.85**	<0.5	No

NC - not calculated.
NA - not applicable.
** concentrations are assumed to be one-half of the detection limit.
*total chromium assumed to be chromium VI (most conservative).
^ uncertainty due to detection limits.
J - estimated concentration.

Table 2
Radioactive COCs at ER Site 57B and Comparison to the Background Screening Values

COC Name	Maximum Concentration (pCi/g)	SNL/NM 95th % or UTL Level (pCi/g)	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?
U-238	1.15[3]	2.31	Yes
U-235	0.125	0.16	Yes
U-234	0.80	2.31	Yes
Th-232	1.41	1.03	No
Ra-228	1.18	1.08	No
Th-228	1.60	1.08[1]	No
Th-230	1.22	2.31[2]	Yes

Note 1: Th-228 background assumed to be that of its parent nuclide Ra-228.
Note 2: Th-230 background assumed to be that of its parent nuclide U-234.
Note 3: Based on the maximum reported concentration of the U-238 short-lived daughter Th-234.

Table 3
Nonradioactive Toxicological Parameter Values for ER Site 57B COCs

COC Name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	Sf_o (kg-d/mg)	SF_{inh} (kg-d/mg)	Cancer Class ^
Arsenic	0.0003	--	M	1.5	15.1	A
Barium	0.07	0.000143	M	--	--	D
Beryllium	0.005	--	L	4.3	8.4	B2
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	0.005	--	L	--	42	A
Mercury	0.0003	0.0000857	M	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	L	--	--	D
2,4,6-Trinitrotoluene	0.0005	--	M	0.03	--	C
2,4-Dinitrotoluene	0.002	--	H	--	--	B2
2,6-Dinitrotoluene	0.001	--	--	--	--	B2
2-Nitrotoluene	0.01	--	--	--	--	--
3-Nitrotoluene	0.01	--	--	--	--	--
4-Nitrotoluene	0.01	--	--	--	--	--
HMX	0.05	--	--	--	--	--
1,3-Dinitrobenzene	0.0001	--	L	--	--	D
RDX	0.003	--	--	0.11	--	--
1,3,5-Trinitrobenzene	0.00005	--	L	--	--	D
Tetryl	0.01	--	--	--	--	--
2-Am-4,6-DNT**	--	--	--	0.68	--	--
4-AM-2,6-DNT**	--	--	--	0.68	--	--
PETN	--	--	--	--	--	--
Nitroglycerin	--	--	--	--	--	--
Nitrobenzene	0.0005	0.000571	L	--	--	D

* total chromium assumed to be chromium VI (most conservative).
RfD_o - oral chronic reference dose in mg/kg-day.
RfD_{inh} - inhalation chronic reference dose in mg/kg-day.
Confidence - L = low, M = medium, H = high.
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$.
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$.
^ EPA weight-of-evidence classification system for carcinogenicity:
A - human carcinogen.
B1 - probable human carcinogen. Limited human data are available.
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen.
D - not classifiable as to human carcinogenicity.
-- information not available.

Table 4
Radiological Toxicological Parameter Values for ER Site 57B COCs

COC Name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class^
Th-232	3.3E-11	1.9E-8	2.0E-11	A
Ra-228	2.5E-10	9.9E-10	3.3E-6	A
Th-228	2.3E-10	9.7E-8	9.9E-7	A

SF_o - oral (ingestion) slope factor (risk/pCi).
SF_{inh} - inhalation slope factor (risk/pCi).
SF_{ev}- external volume exposure slope factor (risk/yr per pCi/g).
^ EPA weight-of-evidence classification system for carcinogenicity:
A - human carcinogen.
B1 - probable human carcinogen. Limited human data are available.
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen.
D - not classifiable as to human carcinogenicity.
E - evidence of noncarcinogenicity for humans.

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (EPA 1988a).

- The DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (DOE 1988).

- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Health Physics 28:193-205) (Kocher 1983) and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993a).

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization, including the Hazard Index value and the excess cancer risk, for both the potential nonradiological COCs and associated background for industrial and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for industrial and residential land uses.

II.3.3.1 Exposure Assessment

Appendix 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (EPA 1989). The parameters are based on information from RAGS (EPA 1989), as well as other EPA guidance documents, and reflect the RME approach advocated by RAGS (EPA 1989). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the incremental TEDE and cancer risk for the individual exposure pathways. Further discussion of this process is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu et al. 1993b).

Although the designated land-use scenario is industrial for this site, the risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective of the potential for risk to human health under the more restrictive land-use scenario.

II.3.3.2 Risk Characterization

Table 5 shows that for the ER Site 57B nonradioactive COCs, the Hazard Index value is 0.2, and the excess cancer risk is 3×10^{-5} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs. Table 6 shows that assuming the maximum background concentrations of the ER Site 57B associated nonradiological background constituents, the Hazard Index is 0.03, and the excess cancer risk is 7×10^{-6} for the designated industrial land-use scenario.

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The incremental TEDE for industrial land-use is 1.2 millirem per year (mrem/yr). In accordance with proposed EPA guidance, the standard being utilized is an incremental TEDE of 15 mrem/yr (40 CFR Part 196 1994) for the probable land-use scenario (industrial in this case); the calculated dose value for ER Site 57B for the industrial land-use scenario is below this standard. The estimated excess cancer risk is 2×10^{-5}.

For the residential land-use scenario, the Hazard Index value increases to 32, and the excess cancer risk is 5×10^{-4}. The numbers presented include exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 6 shows that for the ER Site 57B associated nonradiological background constituents, the Hazard Index increases to 2, and the excess cancer risk is 1×10^{-4}.

Table 5
Nonradioactive Risk Assessment Values for ER Site 57B COCs

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	42 J	0.14	3E-5	2.40	5E-4
Barium	190	0.00	--	0.03	--
Beryllium	0.69 J	0.00	1E-6	0.00	5E-6
Cadmium	1.1**	0.00	4E-10	0.90	6E-10
Chromium, total*	18	0.00	5E-8	0.01	7E-8
Mercury	0.34	0.00	--	0.59	--
Selenium	78 J	0.02	--	27.44	--
Silver	0.85**	0.00	--	0.04	--
2,4,6-Trinitrotoluene	0.12**	0.00	2E-9	0.00	6E-9
2,4-Dinitrotoluene	0.13**	0.00	--	0.06	--
2,6-Dinitrotoluene	0.12**	0.00	--	0.00	--
2-Nitrotoluene	0.12**	0.00	--	0.00	--
3-Nitrotoluene	0.12**	0.00	--	0.00	--
4-Nitrotoluene	0.12**	0.00	--	0.00	--
HMX	1.2**	0.00	--	0.00	--
PETN	0.08** H	--	--	--	--
RDX	0.5**	0.00	2E-8	0.00	9E-8
Nitroglycerin	0.02** H	--	--	--	--
1,3-Dinitrobenzene	0.12**	0.00	--	0.00	--
1,3,5-Trinitrobenzene	0.12**	0.00	--	0.01	--
Tetryl	0.31**	0.00	--	0.00	--
2-Am-4,6-DNT^	0.12**	0.00	3E-8	0.00	1E-7
4-Am-2,6-DNT^	0.12**	0.00	3E-8	0.00	1E-7
Nitrobenzene	0.13**	0.00	--	0.29	--
TOTAL		**0.2**	**3E-5**	**32**	**5E-4**

* total chromium assumed to be chromium VI (most conservative).
** concentrations are assumed to be one-half of the detection limit.
J - estimated concentration.
H - sample analyzed past holding time.
-- information not available.
^ used toxicological parameter values for dinitrotoluene mixture in calculation.

Table 6
Risk Assessment Values for ER Site 57B Background Constituents

Constituent Name	Background concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	9.8	0.03	6E-6	0.56	1E-4
Barium	246	0.00	--	0.04	--
Beryllium	0.75	0.00	1E-6	0.00	6E-6
Cadmium	0.64	0.00	3E-10	0.52	4E-10
Chromium, total*	NC	--	--	--	--
Mercury	0.055	0.00	--	0.09	--
Selenium	3.0	0.00	--	1.06	--
Silver	<0.5	--	--	--	--
TOTAL		**0.03**	**7E-6**	**2**	**1E-4**

-- information not available.
* total chromium assumed to be chromium VI (consistent with Table 5).
NC - not calculated.

For the radioactive COCs, the incremental TEDE for residential land-use is 3.5 mrem/yr. In accordance with proposed EPA guidance, the standard being utilized is an excess TEDE of 75 mrem/yr (40 CFR Part 196 1994) for a loss of institutional controls (residential land use in this case); the calculated dose value for ER Site 57B for the residential land use is well below this standard. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196 1994), ER Site 57B should be eligible for unrestricted radiological release as the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/yr. The estimated excess cancer risk is 7×10^{-5}. The excess cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (EPA 1989).

II.4 Step 6. Comparison of Risk Values to Numerical Guidelines.

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated for the nonradioactive COCs is 0.2; this is much less than the numerical guideline of 1 suggested in RAGS (EPA 1989). The excess cancer risk is estimated at 3×10^{-5}. In RAGS, the EPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical guideline; the value calculated for this site is in the middle of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard

Index is 0.03. The excess cancer risk is estimated at 7×10^{-6}. Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed within the text. The incremental Hazard Index is 0.13, and the incremental cancer risk is 2.4×10^{-5} for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from the COCs considering an industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the incremental TEDE is 1.2 mrem/yr, which is less than the numerical standard of 15 mrem/yr suggested in the draft EPA guidance. The incremental estimated excess cancer risk is 2×10^{-5}.

For the residential land-use scenario, the calculated Hazard Index for the nonradioactive COCs is 32, which is above the numerical guidance. The excess cancer risk is estimated at 5×10^{-4}; this value is above the upper limit of the suggested acceptable risk range. The Hazard Index for associated background for the residential land-use scenario is 2. The excess cancer risk is estimated at 1×10^{-4}. For the residential land-use scenario, the incremental Hazard Index is 29.5, and the incremental cancer risk is estimated at 4×10^{-4}. These incremental risk calculations indicate significant contribution to human health risk from the COCs considering a residential land-use scenario.

The incremental TEDE from the radioactive components is 3.5 mrem/yr, which is less than the numerical standard of 75 mrem/yr suggested in the draft EPA guidance. The estimated excess cancer risk is 7×10^{-5}.

II.5 Step 7 Uncertainty Discussion

The data used to characterize ER Site 57B were provided by samples collected at 19 locations across the site. The number of samples was proposed in the draft RCRA Facility Investigation (RFI) Work Plan for operable unit (OU) 1334. The site covers approximately 11.13 acres, and the number of samples was deemed sufficient to establish whether residues from the proximity-fuze testing were detectable. The COCs for the site are metals and high explosive (HE) residue. Samples were also collected for radiological characterization (depleted uranium and isotopic uranium and thorium). Thirty-three soil samples were analyzed for HE by high-pressure liquid chromatography or Micellar Electrokinetic Capillary Chromatography (MEKC) at the on-site laboratory; six split samples were analyzed by EPA Method 8330 at an off-site laboratory Thirty-seven samples were analyzed on site, and seven were analyzed off site for RCRA metals and beryllium by EPA Method 6010/7000. Ten samples were analyzed on site for radionuclides using gamma spectroscopy. Ten samples were analyzed off site for isotopic uranium and isotopic thorium using alpha spectroscopy.

All off-site data underwent a Level III data validation by IT Corporation, Albuquerque, New Mexico. Any problems were identified, and the data were qualified accordingly. These data are considered definitive and suitable for use in a risk assessment analysis.

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are within the acceptable range compared to

established numerical guidelines for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate insignificant risk to human health from nonradiological COCs when considering the industrial land-use scenario.

For the radiological COCs, the conclusion from the risk assessment is that the potential effects on human health, for both the industrial and residential land-use scenario, are well within proposed standards (40 CFR Part 196 1994) and are a small fraction of the estimated 290 millirem per year (mrem/yr) received due to natural background (NCRP 1987).

The potential effects on human health for the nonradiological COCs are greater when considering the residential land-use scenario. Incremental risk between potential nonradiological COCs and associated background also indicates an increased contribution of risk from the nonradiological COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels) contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 57B is designated as an industrial land-use area (DOE and USAF 1995), the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is considered to be small.

Because of the location, the history of the site, and the future land-use (DOE and USAF 1995), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs were used to provide conservative results.

Table 3 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (EPA 1996b) and Integrated Risk Information System (IRIS) (EPA 1988b, 1997a) databases. Where values are not provided, information is not available from HEAST, IRIS, or EPA regions. The constituents without toxicological parameters have low concentrations are judged to be insignificant contributors to the overall risk. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The nonradiological risk assessment values are within the acceptable range for the industrial land-use scenario compared to the established numerical guidelines. Though the residential land-use Hazard Index is above the numerical guideline and the excess cancer risk is above the upper limit of the acceptable risk range, it has been determined that future land use at this locality will not be residential (DOE and USAF 1995). The overall uncertainty in all of the steps

in the risk assessment process is considered insignificant with respect to the conclusion reached.

II.6 Summary

ER Site 57B, the Workman Site: Target Area, had potential contamination consisting of some nonradioactive metals and explosives and radioactive compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario (DOE and USAF 1995), and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land use (DOE and USAF 1995); the residential land-use scenario is provided for perspective only.

Using conservative assumptions and employing an RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.2) is significantly less than the accepted numerical guidance from the EPA. The estimated cancer risk (3×10^{-5}) is in the middle of the suggested acceptable risk range. The incremental Hazard Index is 0.13, and the incremental cancer risk is 2.4×10^{-5} for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk to human health from the nonradiological COCs considering an industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are less than EPA guidance values; the estimated TEDE is 1.2 mrem/yr for the industrial land-use scenario. This value is less than the numerical guidance of 15 mrem/yr (for industrial) in draft EPA guidance. The corresponding incremental estimated cancer risk value is 2×10^{-5} for the industrial land-use scenario.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. It is therefore concluded that this site does not have significant potential to affect human health under an industrial land-use scenario.

III. Ecological Risk Assessment

III.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils from ER Site 57B. The ecological risk assessment process performed for this site is a screening level assessment that follows the methodology presented in IT Corporation (1997b) and SNL/NM (1997). The methodology was based on screening level guidance presented by EPA (EPA 1992, 1996c, 1997b) and by Wentsel et al. (1996) and is consistent with a phased approach. This assessment utilizes conservatism in the estimation of ecological risks; however, ecological relevance and professional judgment are also incorporated as recommended by EPA (1996c) and Wentsel et al. (1996) to ensure that the predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

III.2 Site Description and Ecological Pathways

ER Site 57B is located in an area of disturbed grassland habitat. During the sensitive-species survey at this site, conducted on September 16, 1994 (IT Corporation 1995), the site was found to contain large amounts of debris that was both scattered and piled into rows. The vegetation around the site was largely dominated by the shrub winterfat (*Eurotia lanata*). Ruderal species, such as kochia (*Kochia scoparium*), Russian thistle (*Salsola kali*), and threeawn (*Aristida* spp.), were common within the areas of debris. No sensitive species were found at this site during this survey, and none are expected to occur due to the disturbed nature of the habitat.

The most significant exposure routes for terrestrial receptors are direct uptake by plants and ingestion by wildlife. Direct uptake of COPECs from soil was assumed to be the major route of exposure of plants to COPECs, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994).

III.3 Constituents of Potential Ecological Concern

The COCs at this site are metals and HE. Following the screening process used for the selection of potential COCs for the human health risk assessment, the inorganic COCs were screened against background UTLs. Several inorganic analytes, including arsenic, cadmium, chromium (total), lead, mercury, selenium and silver, were identified as COPECs at ER Site 57B. Although cadmium and silver were not detected, they were included as COPECs because of the high detection limits. HE was not detected; however, because explosive compounds do not have calculated background values, they are carried into the risk assessment analysis. Radionuclide COPECs for this site were radium-228, thorium-228, and thorium-232.

III.4 Receptors and Exposure Modeling

A nonspecific perennial plant was used as the receptor to represent plant species at the site. Two wildlife receptors (deer mouse and burrowing owl) were used to represent wildlife use of the site. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion. Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled as an omnivore (50 percent of its diet is plants and 50 percent is soil invertebrates), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet is deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 7 presents the species-specific factors used in modeling exposures in the wildlife receptors. Although home range is also included in this table, exposures for this screening-level assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated.

Table 7
Exposure Factors for Ecological Receptors at Environmental Restoration Site 57B, Sandia National Laboratories, New Mexico

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/d)[b]	Dietary Composition[c]	Home Range (acres)
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	0.0239[d]	0.00372	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	0.27[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	0.155[f]	0.0173	Rodents: 100% (+ Soil at 2% of Intake)	34.6[g]

[a]Body weights are in kilograms wet weight..
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2 percent of food intake.
[d]From Silva and Downing (1995).
[e]From EPA (1993), based on the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).

The maximum measured COPEC concentrations from both surface and subsurface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site. In the case of cadmium and silver, detection limits from the on-site laboratory exceeded the measured concentrations of from the off-site laboratory. One-half of the detection limits from the on-site laboratory were used as the cadmium and silver concentration in soil at this site. One-half the detection limits from the on-site laboratory were also used for HE compounds, which were not otherwise detected but were retained due to the high detection limit.

Table 8 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 9 presents the maximum concentrations of COPECs in soil, the derived concentrations in the various food-chain elements, and the modeled dietary exposures for each of wildlife receptor species.

III.5 Toxicity Benchmarks

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 10. For plants, the benchmark soil concentrations are based on the lowest-observed-adverse-effect level (LOAEL), with the adverse effect being a 20 percent reduction of growth. For wildlife, the toxicity benchmarks are based on the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Avian toxicity values for beryllium and silver were not found in the literature. In addition, insufficient toxicity data for the HE compounds precluded estimating potential risk to the terrestrial plant and burrowing owl.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also offer sufficient protection to other components within the terrestrial habitat of ER Site 57B.

III.6 Risk Characterization

The maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 11. Hazard quotients (HQ) are used to quantify the comparison with the benchmarks for plants and wildlife exposure. Maximum soil concentrations for arsenic, chromium (total), mercury, and selenium exceeded their respective plant benchmark values. In the deer mouse, HQs exceeded unity for arsenic (HQ = 26.5), selenium (HQ = 23.9), RDX (HQ = 1.77), dinitrobenzene (HQ = 1.25), 1,3,5-trinitrobenzene (HQ = 31), and tetryl (HQ = 9.2). In the burrowing owl, HQs exceeded unity for mercury (HQ = 4.84) and selenium (HQ = 5.15) exceeded unity.

Table 8
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at Environmental Restoration Site 57B, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Arsenic	4.00×10^{-2} [a]	1.00×10^{0} [b]	2.00×10^{-3} [a]
Cadmium	5.50×10^{-1} [a]	6.00×10^{-1} [c]	5.50×10^{-4} [a]
Chromium (total)	4.00×10^{-2} [a]	1.30×10^{0} [b]	3.00×10^{-2} [d]
Lead	9.00×10^{-2} [a]	4.00×10^{-2} [b]	8.00×10^{-4} [a]
Mercury	1.00×10^{0} [a]	1.00×10^{0} [b]	2.50×10^{-1} [d]
Selenium	5.00×10^{-1} [d]	1.00×10^{0} [b]	1.00×10^{-1} [d]
Silver	1.00×10^{0} [d]	2.50×10^{-1} [c]	5.00×10^{-3} [d]
HMX	2.74×10^{1} [e]	1.36×10^{1} [f]	3.42×10^{-6} [e]
PETN	2.78×10^{-1} [e]	2.78×10^{-1} [f]	1.25×10^{-4} [e]
RDX	1.22×10^{1} [e]	1.45×10^{1} [f]	1.46×10^{-7} [e]
2,4,6-trinitrotoluene	4.60×10^{0} [e]	1.58×10^{1} [f]	8.28×10^{-7} [e]
2,4-dinitrotoluene	2.78×10^{0} [e]	1.65×10^{1} [f]	2.04×10^{-6} [e]
2,6-dinitrotoluene	3.93×10^{0} [e]	1.60×10^{1} [f]	1.10×10^{-6} [e]
Nitroglycerin	4.48×10^{0} [e]	1.59×10^{1} [f]	8.68×10^{-7} [e]
3-nitrotoluene	1.49×10^{0} [e]	1.74×10^{1} [f]	6.25×10^{-6} [e]
2-nitrotoluene	1.81×10^{0} [e]	1.71×10^{1} [f]	4.37×10^{-6} [e]
4-nitrotoluene	1.65×10^{0} [e]	1.73×10^{1} [f]	5.17×10^{-6} [e]
1,3-dinitrobenzene	5.33×10^{0} [e]	1.56×10^{1} [f]	6.37×10^{-7} [f]
1,3,5-trinitrobenzene	8.96×10^{0} [e]	1.49×10^{1} [f]	2.52×10^{-7} [f]
Tetryl	4.31×10^{0} [e]	1.59×10^{1} [f]	9.32×10^{-7} [f]
2-Am-4,6-DNT	2.78×10^{0} [e]	1.65×10^{1} [f]	2.04×10^{-6} [f]
4-Am-2,6-DNT	2.78×10^{0} [e]	1.65×10^{1} [f]	2.04×10^{-6} [f]
Nitrobenzene	3.30×10^{0} [e]	1.63×10^{1} [f]	1.50×10^{-6} [f]

[a] From Baes et al. (1984).
[b] Default value.
[d] From Stafford et al. (1991).
[c] From NCRP (1989).
[e] From equations developed in Travis and Arms (1988).
[f] From equations developed in Connell and Markwell (1990).

Table 9
Media Concentrations for Constituents of Potential Ecological Concern at Environmental Restoration Site 57B, Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Soil (maximum)[a]	Plant Foliage[a,b]	Soil Invertebrate[a,b]	Deer Mouse Tissues[a,c]
Arsenic	4.20×10^{1}	1.68×10^{0}	4.20×10^{1}	1.42×10^{-1}
Cadmium	1.1×10^{0}	6.05×10^{-1}	6.60×10^{-1}	1.12×10^{-3}
Chromium (total)	1.80×10^{1}	7.20×10^{-1}	2.34×10^{0}	1.77×10^{-1}
Lead	3.40×10^{1}	3.06×10^{0}	1.36×10^{0}	7.23×10^{-3}
Mercury	3.40×10^{-1}	3.40×10^{-1}	3.40×10^{-1}	2.71×10^{-1}
Selenium	7.80×10^{1}	3.90×10^{1}	7.80×10^{1}	1.88×10^{1}
Silver	8.50×10^{-1}	8.50×10^{-1}	2.13×10^{-1}	8.57×10^{-3}
HMX	1.2×10^{0}	3.29×10^{1}	1.63×10^{1}	2.63×10^{-6}
PETN	8.0×10^{-2}	2.22×10^{-2}	1.61×10^{0}	3.20×10^{-4}
RDX	5.0×10^{-1}	6.08×10^{0}	7.27×10^{0}	3.05×10^{-6}
2,4,6-trinitrotoluene	1.20×10^{-1}	5.53×10^{-1}	1.90×10^{0}	3.17×10^{-6}
2,4-dinitrotoluene	1.3×10^{-1}	3.61×10^{-1}	2.15×10^{0}	8.03×10^{-6}
2,6-dinitrotoluene	1.20×10^{-1}	4.71×10^{-1}	1.92×10^{0}	4.13×10^{-6}
Nitroglycerin	2.0×10^{-2}	8.97×10^{-2}	3.17×10^{-1}	5.53×10^{-7}
3-nitrotoluene	1.2×10^{-1}	2.18×10^{-1}	2.06×10^{0}	2.22×10^{-5}
2-nitrotoluene	1.2×10^{-1}	1.78×10^{-1}	2.09×10^{0}	1.56×10^{-5}
4-nitrotoluene	1.2×10^{-1}	1.98×10^{-1}	2.07×10^{0}	1.84×10^{-5}
1,3-dinitrobenzene	1.20×10^{-1}	6.40×10^{-1}	1.87×10^{0}	2.51×10^{-6}
1,3,5-trinitrobenzene	1.20×10^{-1}	1.07×10^{0}	1.79×10^{0}	1.13×10^{-6}
Tetryl	3.10×10^{-1}	1.34×10^{0}	4.93×10^{0}	9.14×10^{-6}
2-Am-4,6-DNT	1.20×10^{-1}	2.78×10^{0}	1.98×10^{0}	7.41×10^{-6}
4-Am-2,6-DNT	1.20×10^{-1}	2.78×10^{0}	1.98×10^{0}	7.41×10^{-6}
Nitrobenzene	1.30×10^{-1}	3.30×10^{0}	2.12×10^{0}	5.98×10^{-6}

[a]Milligrams per kilogram. All are based on dry weight of the media.

[b]Product of the soil concentration and the corresponding transfer factor.

[c]Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).

Table 10
Toxicity Benchmarks for Ecological Receptors at Environmental Restoration Site 57B, Sandia National Laboratories, New Mexico

		Mammalian NOAELs (mg/Kg/d)			Avian NOAELs (mg/Kg/d)		
Constituent of Potential Ecological Concern	Plant Benchmark[a] (mg/Kg)	Mammalian Test Species[b]	Test Species NOAEL[c]	Deer Mouse NOAEL[d]	Avian Test Species[e]	Test Species NOAEL[e]	Burrowing Owl NOAEL[f]
Arsenic	10	Lab mouse	0.126	0.13	Mallard	5.14	5.14
Cadmium	3	Lab rat	1	1.89	Mallard	1.45	1.45
Chromium (total)	1	Lab rat	2737	5354	Black Duck	1	1.00
Lead	50	Lab rat	8	15.7	Am kestrel	3.85	3.85
Mercury	0.3	Lab rat	0.032	0.06	Mallard	0.0064	0.0064
Selenium	1	Lab rat	0.2	0.39	Screech owl	0.44	0.44
Silver	2	Lab rat[g]	17.8[g]	34.8	---[h]	---	---
HMX	---	Lab rat[g]	10[g]	19.6	---	---	---
PETN		Lab mouse[g]	5870[g]	6213	---	---	---
RDX	---	Lab rat[g]	0.3[g]	0.587	---	---	---
2,4,6-trinitrotoluene	---	Lab rat[i]	1.6[i]	3.13	---	---	---
2,4-dinitrotoluene	---	Lab rat[i]	0.54[i]	1.06	---	---	---
2,6-dinitrotoluene	---	Lab rat[i]	0.36[i]	0.704	---	---	---
Nitroglycerin		Lab mouse[g]	96.4[g]	4.22	---	---	---
3-nitrotoluene	---	Lab rat[i]	2.16[i]	4.23	---	---	---
2-nitrotoluene	---	Lab rat[i]	1.79[i]	3.50	---	---	---
4-nitrotoluene	---	Lab rat[i]	3.94[i]	7.71	---	---	---
1,3-dinitrobenzene	---	Lab rat[g]	0.08[g]	0.16	---	---	---
1,3,5-trinitrobenzene	30	Lab rat[k]	0.37[k]	0.72	---	---	---
Tetryl	---	Lab rat[i]	13[i]	25.4	---	---	---
2-Am-4,6-DNT	---	Lab rat[i]	2.81[i]	5.50	---	---	---
4-Am-2,6-DNT	---	Lab rat[i]	1.93[i]	3.78	---	---	---
Nitrobenzene	---	Lab mouse[k]	1.17[k]	1.23	---	---	---

[a] From Will and Suter (1995).

[b] From Sample et al. (1996), except where noted. Body weights (in kilograms) for no-observed-adverse-effect level (NOAEL) conversion are: lab mouse, 0.030; lab rat, 0.350 (except where noted and for cadmium, 0.303); and mink, 1.0.

[c] From Sample et al. (1996), except where noted.

[d] Based on NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.239 kilograms and a mammalian scaling factor of 0.25.

[e] From Sample et al. (1996).

[f] Based on NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.

[g] From EPA (1997a).

[h] --- designates insufficient toxicity data.

[i] From Ryon (1987).

[j] Estimated using lethal dose resulting in death of 50 percent of the test population (LD_{50}) information specific to the compound (e.g., RTECS, 1997) and LD_{50} and NOAEL information for 2,4,6-trinitrotoluene as described in Sample et al. (1996).

[k] Estimated using LD_{50} information specific to the compound (e.g., RTECS, 1997) and LD_{50} and NOAEL information for m-dinitrobenzene as described in Sample et al. (1996).

[l] From Talmage et al. (1996).

Table 11
Comparisons to Toxicity Benchmarks for
Ecological Receptors at
Environmental Restoration Site 57B,
Sandia National Laboratories, New Mexico

Constituent of Potential Ecological Concern	Plant Hazard Quotient[a]	Deer Mouse Hazard Quotient	Burrowing Owl Hazard Quotient
Arsenic	**4.20×10^{0}**	**2.65×10^{1}**	2.13×10^{-2}
Cadmium	3.67×10^{-1}	5.40×10^{-2}	1.78×10^{-3}
Chromium (total)	**1.80×10^{1}**	5.49×10^{-5}	5.99×10^{-2}
Lead	6.80×10^{-1}	2.87×10^{-2}	1.99×10^{-2}
Mercury	**1.13×10^{0}**	8.62×10^{-1}	**4.84×10^{0}**
Selenium	**7.80×10^{1}**	**2.39×10^{1}**	**5.15×10^{0}**
Silver	4.25×10^{-1}	2.45×10^{-3}	---
HMX	---	1.96×10^{-1}	---
PETN	---	2.05×10^{-5}	---
RDX	---	**1.77×10^{0}**	---
2,4,6-trinitrotoluene	4.00×10^{-3}	1.92×10^{-2}	---
2,4-dinitrotoluene	---	1.85×10^{-1}	---
2,6-dinitrotoluene	---	2.65×10^{-1}	---
Nitroglycerin	---	3.11×10^{-4}	---
3-nitrotoluene	---	4.19×10^{-2}	---
2-nitrotoluene	---	5.07×10^{-2}	---
4-nitrotoluene	---	2.30×10^{-2}	---
1,3-dinitrobenzene	---	**1.25×10^{0}**	---
1,3,5-trinitrobenzene	---	3.09×10^{-1}	---
Tetryl	---	1.92×10^{-1}	---
2-Am-4,6-DNT	---	3.92×10^{-2}	---
4-Am-2,6-DNT	---	4.78×10^{-2}	---
Nitrobenzene	---	1.60×10^{-1}	---

[a] **Bold** text indicates potential ecological risk.

[b] --- designates insufficient toxicity data available for risk estimation purposes.

With reference to the radionuclides, total radiation dose to the mouse and owl were 8.9×10^{-5} and 1.3×10^{-4} rad/day, respectively (Tables 12 and 13). These values are considerably less than the benchmark of 0.1 rad/day. The radionuclides within ER Site 57B soils should not be hazardous to terrestrial receptors associated with the site.

III.7 Uncertainties

Many uncertainties are associated with the characterization of ecological risks at ER Site 57B. These uncertainties result in the use of assumptions in estimating risk that may lead to an overestimation or underestimation of the true risk presented at a site. For this screening level risk assessment, assumptions are made that are more likely to overestimate risk rather than to underestimate it. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured soil concentration or one-half the detection limit to evaluate risk, the use of wildlife toxicity benchmarks based on laboratory NOAEL values or estimated NOAELs based on toxicity information on surrogate compounds (e.g., many of the munitions), the use of maximum transfer factors found in the literature for modeling plant and mouse tissue concentrations, the use of earthworm-based transfer factors or a default factor of 1.0 for modeling COPECs into soil invertebrates, and the use of 1.0 as the use factor for wildlife receptors regardless of seasonal use or home range size. In addition, risks to plants and birds from exposure to the HE compounds could not be estimated due to the lack of toxicity information.

Uncertainties associated with the estimation of risk to ecological receptors following exposure to radium-228, thorium-228, and thorium-232 are primarily related to those inherent in the dose rate models and related exposure parameters. The external dose rate models are based on the assumption that the receptor is underground in soil uniformly contaminated with the maximum detected concentration of the radionuclides present at the site. The internal models are based on the assumption that ingested radionuclides are present at the center of a spherical-shaped receptor, forming a point source of radiation. The receptor is assumed to be exposed uniformly from this source of radiation at the center and receives a total-body dose.

III.8 Summary

Potential risks were indicated for all three ecological receptors at ER Site 57B; however, the use of the maximum measured soil concentration or one-half the maximum detection limit to evaluate risk provided a conservative exposure scenario for the risk assessment and may not reflect actual site conditions. One-half detection limit values were used to evaluate risk for cadmium, silver, and HE compounds. Maximum measured soil concentrations for arsenic, chromium, mercury, and selenium exceeded their respective plant benchmark values. HQs greater than 1.0 were estimated for the deer mouse exposed to arsenic, selenium, RDX, dinitrobenzene, 1,3,5-trinitrobenzene, and tetryl. Selenium and mercury resulted in HQs greater than 1.0 for the burrowing owl. Due to insufficient toxicity data for most HE compounds, potential risk estimates could not be determined for the terrestrial plant or the burrowing owl. In

Table 12
Internal and External Dose Rates for
Mice Exposed to Radionuclides at
Environmental Restoration Site 57B,
Sandia National Laboratories, New Mexico

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
Ra-228	1.18	8.79×10^{-6}	NA*	8.79×10^{-5}
Th-232	1.41	7.72×10^{-8}	1.29×10^{-7}	2.06×10^{-7}
Th-228	1.60	1.00×10^{-7}	3.75×10^{-7}	4.76×10^{-7}
Total		8.81×10^{-5}	5.04×10^{-7}	8.86×10^{-5}

* NA = Not applicable. Ra-228 does not significantly contribute to the external dose rate.

Table 13
Internal and External Dose Rates for
Owl Exposed to Radionuclides at
Environmental Restoration Site 57B,
Sandia National Laboratories, New Mexico

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
Ra-228	1.18	1.30×10^{-4}	NA*	1.30×10^{-4}
Th-232	1.41	1.09×10^{-7}	1.29×10^{-7}	2.38×10^{-7}
Th-228	1.60	1.42×10^{-7}	3.75×10^{-7}	5.17×10^{-7}
Total		1.30×10^{-4}	5.04×10^{-7}	1.31×10^{-4}

* NA = Not applicable. Ra-228 does not significantly contribute to the external dose rate.

addition, insufficient toxicity data were available to evaluate potential risk to birds exposed to beryllium or silver. Radionuclides were not predicted to be hazardous to ecological receptors.

Closer examination of the analytical data indicates that many of the hazardous concentrations are similar to those of background samples. Arsenic soil data from the on-site laboratory were primarily nondetects; however, a few of the on-site laboratory results had J values (the highest was 42 mg/kg [J]), which produced the HQs greater than 1 for the plant and the deer mouse. None of the off-site laboratory values for arsenic exceeded the background arsenic concentration of 9.8 mg/kg. Although chromium resulted in an HQ greater than 1, the site-background concentration for chromium (18.8 mg/kg) is actually greater than the ER Site 57B maximum detected concentration of 18.0 mg/kg. No ecological risk from exposure to chromium is therefore predicted. (Chromium was carried through the ecological risk assessment to be consistent with the human health risk process.) Four of the forty-one samples analyzed for mercury were at detectable levels, of which the maximum concentration (0.34 mg/kg) resulted

in HQs for the plant and the burrowing owl of less than 5. The average mercury concentration in the site is estimated to be similar to background. The potential contaminated area in the site is very small compared to the home range of the burrowing owl. The owl is not expected to be at risk by the presence of the few elevated mercury soil concentrations. Overall ecological risks associated with ER Site 57B are expected to be very low.

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APPENDIX 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM ER sites have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM ER sites. At this time, all SNL/NM ER sites have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based on a residential land use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index, risk and dose values. EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;
- Inhalation of airborne compounds (vapor phase or particulate), and;

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based on the location of the SNL ER sites and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM ER site:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based on this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil

Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., Hazard Quotient/Index, excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \qquad (1)$$

where

- C = contaminant concentration (site specific);
- CR = contact rate for the exposure pathway;
- EFD = exposure frequency and duration;
- BW = body weight of average exposure individual;
- AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or hazard index) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land-use, SNL will provide risk parameter values based on a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia ER sites. The parameter values are based on EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2. Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	56[a,b]	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y) for noncarcinogenic compounds (=ED x 365 d/y)	25550[a] 10950	25550[a] 10950	25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/d[c]	6.24 g/y[d]	114 mg-y/kg-d[a]
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	146[d]	5475[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/d)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

*** The exposure frequencies for the land use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land use scenario is 8 h/d for 250 d/y; for the recreational land use, a value of 2 hr/wk for 52 wk/y is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 d/y.

[a] RAGS, Vol 1, Part B (EPA 1991).

[b] Exposure Factors Handbook (EPA 1989b)

[c] EPA Region VI guidance.

[d] For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e] Dermal Exposure Assessment (EPA 1992).

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